AN EFFICIENT, INEXPENSIVE AND FUN-TO-USE CONTRAPTION FOR SAMPLING MOSQUITO LARVAE

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ABSTRACT. An apparatus designed for sampling small mosquito larval habitats is described. Comparisons of this device with other designs reveal a five-fold improvement in fluid transfer efficiency.

The evasive movement of mosquito larvae and the murky nature of their habitats have prompted the development of various specialized devices for larval capture. For larvae found in large aquatic habitats, buckets or dippers can be used to obtain large numbers of larvae fairly efficiently. However, these tools are often awkward to use in habitats that are smaller than the apparatus, including microlimns such as tree holes, tires, ground pools and phytotelmata.

Turkey basters (Service 1976) have long been popular among culicidologists engaged in sampling small environments, owing to their handy size (and consequent high portability), affordability, simplicity of design (and consequent ease of repair) and ease of operation (and consequent savings in training costs). However, the small size of turkey basters limits the efficiency. The need for numerous repeated suction efforts generates tedium, resulting in loss of interest and morale among technical staff.

For sampling arboreal habitats, siphon tubes alleviate some of this tedium because they can withdraw significant quantities of fluid once a flow of water has been initiated. Unfortunately, oral suction applied to such tubes can frequently result in the inhalation of noxious gases or even the accidental ingestion of distasteful or potentially toxic fluids and their biota. Siphon tubes also have limited use when the habitat is located at or near the ground surface. These disadvantages render the siphon tube unsatisfactory as a sampling device. This note describes a new sampling device for collecting mosquito larvae from various small aquatic habitats.

The materials necessary to construct the fluid transfer system include a 22.7 liter plastic gasoline can with a threaded ventilating cap and a pour spout of 4.5 cm (Model 9805, Plastique Anchor Ltee., L'Assomption, Quebec), a rubber drain washer (3.5 cm i.d.), a length of Tygon® tubing (1.5 cm i.d.), a hose clamp sized to fit around the tubing, and a Thirsty-mate® bilge pump with a shaft of 3.8 cm and intake valve of 4.3 cm diam (Beckson Marine Inc., Bridgeport, CT).

We encountered very little difficulty in assembling the device (Fig. 1). We assembled the fluid transfer system in less than 0.5 h on the first attempt, and less than that on subsequent occasions.

Prior to assembly, it is necessary to drill a 1.2 cm hole in the vent hole of the gasoline can, and to remove the intake valve from the bilge pump. Tygon tubing is attached to the modified vent cap with a hose clamp. A length of garden hose with a comparable internal diameter could be substituted for the Tygon tubing, but detection of blockage problems is facilitated with a clear tube.

The cap for the anterior opening of the gasoline can has 2 pieces, including a stopper (not used) and a threaded bushing. The bushing fits around the shaft of the bilge pump, and the gasket, placed beneath the bushing, provides a vapor seal. After the bushing and gasket have been placed on the shaft of the pump, the intake valve can be replaced and the pump can then be fixed with the bushing into the anterior opening of the gasoline can.

After inserting the end of the posterior tube into the larval habitat, repeated pumping actions result in fluid movement through the tubing into the gasoline can reservoir. When the reservoir is filled, it is necessary to transfer the fluid to separate containers to prevent the fluid from being sucked into the bilge pump and expelled through the trunk, which can damage the larvae.

While sampling from tree holes, the only major operational difficulty we have encountered is blockage of the tube at the posterior vent cap, which necessitates tube removal and clearing. Additional problems could result from tube blockage. We have noticed that the pump unit becomes warm to the touch during vigorous operation, especially during blockage, and that the walls of the reservoir bend inward under the force of the vacuum.

Using turkey basters, a sampler similar to that of Waters and Slaff (1987) and the fluid transfer system, we have conducted an empirical test to compare rates of fluid transmission. We compared these 3 methods for moving water held within two 9 liter buckets a vertical distance of 1 m upwards and downwards. Two replicate

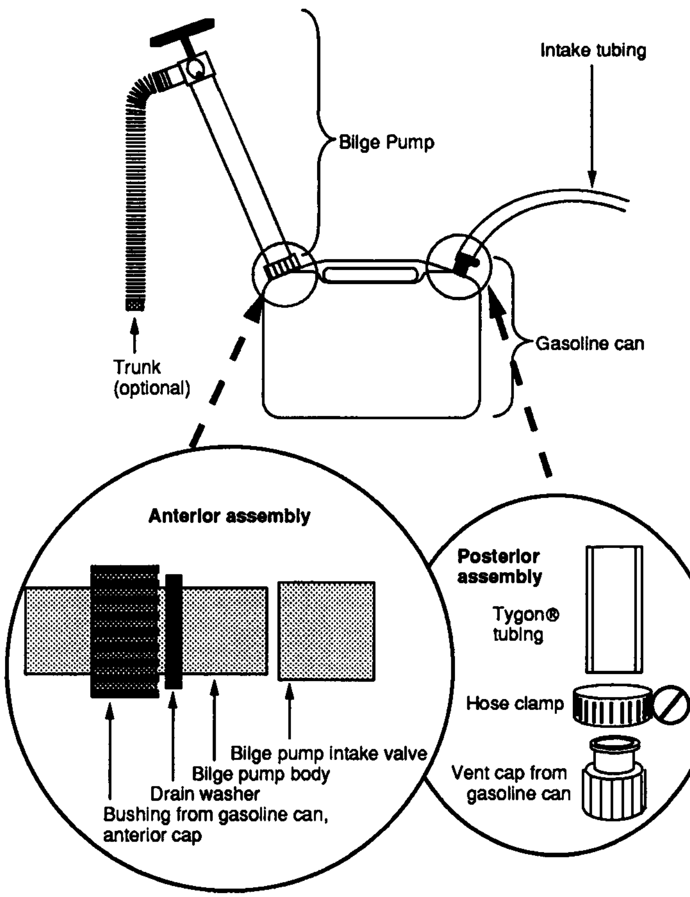

Fig. 1. Lateral view of the fluid transfer system, fully deployed (above), and with assembly details (below). Although the bilge pump is sold with the trunk attached, it could be removed with no major functional loss. We have left ours intact for aesthetic purposes.

trials were conducted for each method, lasting for 4 min (or until all 18 liters had been transferred) with cumulative volume recorded at 30 sec intervals. Coefficients for regressions of cumulative volume on time were used to estimate the average fluid transfer velocities (Fig. 2).

The fluid transfer system provided far more efficient transfer than the other 2 methods, in both uphill and downhill transfers. In all trials, the entire 18 liter volume was transferred in less than 90 sec. Enhanced velocity provided by siphon action is apparent for both the Waters and Slaff device and the fluid transfer system, but the benefits of this siphon effect with the Waters and Slaff method were hindered by the need to empty the container periodically. Worker fatigue was most evident with the turkey baster method, and workers complained of fatigue and dizziness after each 4 min session of inhalation using the Waters and Slaff method.

A modified garden sprayer, similar in design to the fluid transfer system, appears more difficult to assemble and requires a mechanical workshop to convert the pressure pump to a suction pump (Goettel et al. 1981). In addition, the Goettel et al. device may be more prone to blockage because the intake tubing is less than half the diameter of the tubing used in the fluid transfer system, thereby decreasing the efficiency of the garden sprayer sampler in detritus-filled habitats. The narrow tubing would also be inadequate for sampling large pupae or larvae (e.g., *Toxorhynchites* spp.) which would be damaged when forced through the tube's opening.

We anticipate that several modifications could improve the performance of the fluid transfer system for specialized applications. Wheels or laterally mounted shoulder straps would improve the portability of the unit for lengthy field excursions. For elevated arboreal

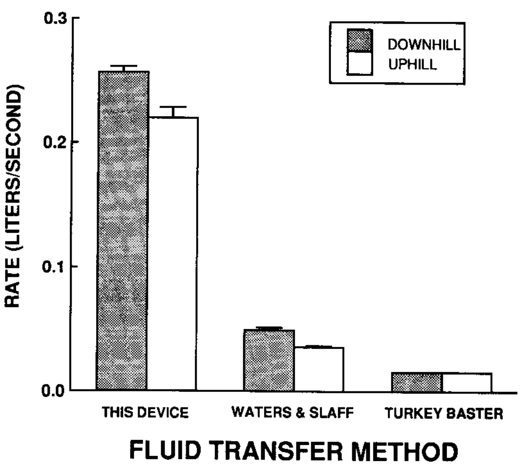

Fig. 2. Comparative efficiencies of three fluid transfer methods. For each method, water was moved either up or down a distance of 1 m from the source. Average rates are calculated as linear regressions of cumulative volume transferred against time, forcing the regression lines through the origin. Standard errors for regression coefficients are shown.

sampling, a telescoping pole affixed to a long intake tube, possibly equipped with a mirror, could reduce the need for commonly used cumbersome or expensive equipment (e.g., stilts, climbing gear, ladders, scaffolding, cherry-pickers, etc). Improvements could also focus on the posterior junction between the gasoline can and the intake tube, including a snap-on hose coupling for more rapid blockage removal.

The fluid transfer system can be assembled for approximately $25, excluding labor. Although this cost is nearly 10 times that estimated for the other 2 devices, the cost could be absorbed within many grant research budgets, and may even fit within the budgets of unsupported investigators at academic institutions.

These preliminary results suggest that the fluid transfer system is a more efficient means of fluid transport than competing methods. However, the results of this laboratory study may not reflect the relative efficiencies of these methods in the full complexity of natural conditions. Further research is clearly warranted to assess the true relative efficiencies of these sampling tools in field situations.

We thank J. Turner and J. MacDonald for technical assistance, and the National Institutes of Health (#R15AI27940) and the National Science Foundation (#BSR-8415952) for supporting projects for which this technology was developed. L. P. Lounibos, J. Washburn and one anonymous reviewer provided thoughtful comments on an earlier draft.

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